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# DESIGN IN INDUSTRY FOR A DEVELOPING NATION

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# DESIGN IN INDUSTRY FOR A DEVELOPING NATION

## GENERAL INTRODUCTION

Design which is the highest form of engineering practice is the pure outcome of creative thinking.

It constitutes the most solid foundation for a healthy and lasting industry and makes the industry capable of achieving continuous development by depending mostly on her own inward resources whether it is manpower, capabilities or general facilities.

This does not necessarily rule out certain dependency on foreign sources but at least it helps to dispose those uneasy feelings that force themselves on those who are responsible for the development of industrial problems in a developing nation. This is particularly the case if the foreign help is not so readily available at hand or if older nations are not so apparently willing and co-operative, a case which is not an unfrequent happening with certain matters and subjects.

Design is in fact an art which must be pursued and practised from the first moment a nation decides to go in the field of industrialization.

It, like any other art, requires long and arduous training combined with individual and personal abilities, readiness and zest.

The designers must be made and for this reason they must be given every opportunity to form and develop themselves. They must be provided with every scientific, technical and technological help from the very start of their career. They must be guided by older people who pass a great deal of practical experience. This guidance must be given for a long enough period to allow them to develop their self-dependency, self-reliance and confidence.

In the meantime those designers must be trained, first and foremost, in the art of dealing with foreign experts and they must be taught the correct methods and procedures which will help them to get from those

experts the best of their stored knowledge and experience without trouble or frustration. They should also be taught the techniques of accepting constructive criticism and the practice of close team-work procedures. Any effort or time spent in the correct achievement of these points can never be considered as too excessive or waste.

It is thus clear that all these pre-training steps require an appreciable duration in the early stages of industrialization of a nation and it becomes essential to proceed with design activities concurrently with the start of industry so as the nation will find her formed designers just at the time when her bought, ready made, factories begin to need their help and just at the time when the newness of these factories are worn out and their troubles begin.

These designers should also be given every opportunity to visit other more advanced nations to see for themselves how team work could be successfully carried out and achieved.

Before going further in detailing the making up of a successful design team or a design centre, it is appropriate to clearly define the concept behind the expression "Design in Industry".

This term has been chosen to replace the more commonly understood term of "Industrial Design".

The term "Industrial Design" has been purposely left out of this article to avoid the misapprehension that is liable to occur in the minds of the people of the old industrial world when they read it.

The expression "Industrial Design" is used by the old industrialization to denote an art of refinement to their existing product. In fact it is an art applied to improve and alter the shape of the product and add to it touches of beauty, streamlining and utility with an endeavour to improve on its economical production.

Thus to their hearing this expression which is in fact represents the advanced stage of our present design work might give them that erroneous feeling that we are trying to put "The Cart before the Horse".

What is Design in Industry

The word DESIGN can indicate such a broad field, it can mean the design of the technological process for a factory, the design of the structure that houses the factory, the design of the various equipments that constitutes the making up of a factory and which is generally termed the engineering design of the factory. It can also mean the design and planning of the site for the factory and its utilities.

In the first stage of design work in a developing nation it is advisable to limit the energy of the new designers to one specific field. In Egypt for the last four years we have been concentrating mostly on the design of equipments in all their various shapes, sizes and forms. We began with the simple bulky equipment such as tanks, vessels and their structures and continued with more intricate work as conveyors in factory transport and special purpose equipment. It has been a struggle against time where we have used every effort and driving power to make up for some of the lost time in that field. On the whole one can say that the bad effect of that short delay in our starting up of design pursuit in our case has been happily damped and offset by the circumstances that were available in our country in the field of Industrialization before the day of our Grand March On-to-Industry.

Though the available efforts at that time were very poor but nevertheless it formed a good stepping stone towards the field of self dependency in local production.

It was the duty of the central design administration which constituted an important division in the General Organization for Industrialization from the starting date of its formation four years ago, to strengthen that poorly fed local jobbing factories with every possible design, drawing, or specification to make their job similar and more in-line with the modern ways that are followed in similar concerns in the old industrial nations.

The Importance of Design for a Developing Nation

Contrary to the general belief and to the common off-hand thought that passes through the minds of most people, our experience has shown without doubt that developing nations with newly established industries are more in need of design facilities than nations with completed and matured industrial structure.

The reason for such a statement is that the developing nation depends on design facilities to maintain their industrial existence by feeding their newly founded industries with their essential needs from worn parts when and where replacement are not available while the advanced industrial nations need their design facilities mainly and foremost for developments, improvements and solving new problems.

Again contrary to the common idea that design should start in the factory, experience has shown that in a developing nation design must start in a central design establishment. It is true that it can finally settle in the factory as the industrial structure of the developing nation gets more established and set.

To explain the reason for such a deviation from the common practice one has to ponder a little on the state of things and the multitude of difficulties the managerial group in a newly built factory face to upkeep the production at its required level. It would then be clear for anybody to see that if a developing nation wants to advance its design capabilities it has to incubate designers, at least during the first stages of industrialization, away from the scene of the factories but in full collaboration with them and to lighten the burden of the managerial staff of these factories by not putting this big responsibility of developing the art of design and designers on the shoulder of these over burdened group. Accordingly some one else should concentrate and devote all his time and effort to build up a suitable nuclei which could finally be sent over to these various factories to coagulate the specific experiences round them.

In so doing a developing country can successfully and in a short time support their quickly put up industries with the design facilities that have taken the older nations years of experience to achieve. In fact this is again a revolutionary way of overcoming these in-abilities suffered by the developing nations. It is about the only way that would hasten the speed of their independence in industry and insures an ever lasting successful industry strong enough to stand the hazards of the early stages of industrialization.

It is no wonder that we developing nations must resort to absolutely new revolutionary measures to make up for the lost time and to catch up with our older brothers in that respect and to stand side by side with them in the field of development and progress.

Before leaving the field of stressing the vital importance of the role that design play in a developing nation, we must consider the two following matters which play a big role in the economical stability of a nation:-

a. The use of indigenous raw materials and the full utilization of local resources and in turn the increase of the volume of employment in all grades of industry.

b. The suitability of foreign designs to the habits and natural instincts of the people in the developing nations.

It is absolutely clear that such items can never be successfully achieved unless the design thoughts and ideas emit from within the country and not from without. It is natural that the experience and knowledge of foreign experts must be sought in many incidents but it is the spirit and the instinct of the national designer that shall finally satisfy and succeed in attaining the highest percentage of achievement with regard to the above two items and in turn constitutes one of the most solid foundation for a healthy and well established economical development.

Thus it is clear that a team of well-trained designers standing side by side with the industrialists in a newly developing nation is a heavenly wealth which can provide quick solutions to their difficulties and problems and can save the disruption of their production. It is indeed the best friend the Industry can ever have in time of need and "A friend in need is a friend indeed".

Scope of Designs in a Developing Nation

In any developing nation there is always a certain amount of latent industrial capabilities which could be looked upon as an essential indigenous raw material and a national wealth and must be given top priority and attendance. Every effort should be made to strengthen and accumulate it rather than to leave it to disseminate in the winds and storms of the commencement era of industrialization. Thus it is the first duty of an industrial planner to develop such capabilities and to harness them correctly so as to extract from them that spark needed for igniting the field of local production in any developing nation.

There are more than one way of achieving such an aim and we shall mention here only some of them:

1. By grouping of such powers in various Industrial Estates and thus providing them with more incentive for good production and giving hem the facilities needed for it.

2. By provoding the small local job shops which may be existing in the country at the start of industrialization era with the technical know-how, them in maintaining the good quality of production through regular inspection and discussion sessions.

3. By encouraging the small scale and cottage industries and guiding them correctly through the media of good and new designs augmented by technical guidance.

In all the above cases the introduction of new ideas and improvements to the nationally practised and generally crude production must be made immense and wide programme for training and the establishment

of training centres and development institutes must be followed to ensure the continuity of the supply of technicians and technologists to every possible spot in the country. The speciality of these centres and institutes must naturally take the colour of the most predominant art in the districts where they are to be established.

These centres and institutes must not only concentrate on the practical training of trainees but must have a large portion of their activity devoted to the training of drafting and design techniques.

In fact this last subject has been so neglected in the developing countries that it has constituted the weakest link in the chain of development.

By following up the development of indigenous and national arts and abilities in the manner explained above the planner will find that he had opened for himself an extensive field of activity and has automatically promoted that important branch of feeding industries which is in fact the back bone of the successful industrial concerns.

Thus it is clear that through the activity detailed above if supported with well balanced designs and properly illustrated drawings the developing country can effectively succeed in fulfilling the following:

1. Solve her maintenance problems in all its mechanical fields whether it is power plants, factories, means of transport of any other mechanical commodity that it uses in every day life and existence. These problems may include the change of designs of imported articles and commodities to suit the local investments and conditions or the solution of spare parts problems.
2. Energize the uses of indigenous raw materials because through design and drafting activities and the re-adaptation of imported items more local means and material could be utilized.

Establishment of a Central Design Office

As mentioned before it has been explained that one or more central design offices are essential to establish in a developing country. In what follows we are going to describe the best shape of such an establishment based on our experience.

First the established office must be in close contact with those organizational concerns who are responsible for the development of the industrial projects of the nation. It should be composed of two main divisions. One division for developing the designs and drawings while the other division should be for following up their local execution and manufacture must also have some sort of an establishment where he can try out and prove the designs made in the first division by building up a proto-type of part or of the whole of the design as the case may be.

The design division should be mainly composed of four sections, one for planning the procedures of the jobs through the centre and help in the designing of the technological process needed for the various jobs within its available capabilities and one for designing of the equipments, parts and various machines and one for designing the production and consumable goods and the fourth for designing the special tools, dyes, jigs and fixture needed for the production of the designed articles developed by the other sections. It should also be capable of working out the main steps needed for processing these designs through the various job shops.

The second main division of the centre should have three sections, one for inspecting the products during their manufacture and one for attending to general matters concerning the development of things within the centre and this should include the production of proto-types, training of personnel and it should maintain a well-developed information centre that could provide the designers of the first division with all the information whether practically, they need technically or technologically during the working out of their designs and the last section

would be for costing, cost control and for carrying out economical studies needed.

The administrative side of the centre must be given the usual attendance needed for good management and smooth running. The utmost care and diligence must be exercised to ensure the full co-operation and the continuous content between one section and the other notwithstanding the various divisions of the centre.

In the meantime we must never forget the beating heart of the place where the drawing and drafting is finally prepared and duplicated. Strict ruling of order and time control must be always kept, a code of practice must be set up and every standard rule in connexion with the production of drawings must be understood by every member of that section and strictly adhered to.

No effort for training of its personnel should be spared and a continuous stream of trainees must flow out of the training division of that sector.

In this respect we would like to pause once more and repeat the importance of grading among drafting people, a matter which as we said before is liable to be neglected or misunderstood in a developing nation. The grades that must exist in that sector should be:

a. The tracer
b. The draftsman
c. The senior draftsman
d. The draftsman designer

These four grades are the back bone of industrial development and they must be kept in a healthy and well trained state.

The annexed diagram (1): show the main outline of the organizational chart as described in this article.

Diagram (2): gives an outline of the shape of things in the prototype shop suggested to be annexed to the second sector of the centre.

Diagram (3): gives a general layout for such a shop and is being attached here for mere guidance to any interested party.

Diagram (4): gives details for some of the tasks each division of centralized design concern is supposed to carry out.

Diagram (5): gives an outline for the balance of informational guidance that should be made available to designers to ensure the availability of all scientific technological and practical knowledge needed for them in such a centre to help them to develop and consolidate their knowledge.

Annex (6): gives to interested parties a picture of the formation and the field of activities of the only central design administration established in the UAR since the year 1961. It also shows how the activities of such a newly established concern has grown so rapidly and is expected to grow further to cover bigger and wider fields of activities. It shows as well a tentative programme for its work in the coming five years.

Stages of Execution and Conclusion

It is important for the planner to consider the gradual growth of design abilities and not to over-push it but just push it forward with a speed harmonizing with the capabilities available at his hand. The resonance and harmony of work in such a centre are so vital to its success, and it is well to guard against - out of turn - notes and disturbances. It is expected that in such a place where creative thinking is the base of everything that development shall be slower than the speed of development in the industry itself. For this reason we stressed the point, at the beginning of this article, that the creation of a central design administration must start with the start of industry to give it time to ripen and develop and be ready at hand when the industry needs it few years after its own start. It should then be able to get over its own teething troubles before it is asked to solve the troubles of others. No effort should be relaxed and every help technical or technological should be made available to them.

To conclude this article it is well to summarize the main points that a planner should consider when planning to set up the central design concern in his country.

1. To consider the speed of the technical growth of his counter men and to plan to push design matters forward with a speed harmonizing with the capabilities at hand.

2. To set a lengthy and orderly programme for acquiring technical and practical help from foreign sources with an increasing resonance to harmonize with the widening of the field of design activity.

3. To define priorities and specific trends of activities and to begin by developing the existing national arts capabilities and to augment them gradually with other specialities which have the closest relation with indigenous materials and capabilities.

4. To prepare a long-term programme for the training and up-grading of personnel in the various specialities of the design fields so as to ensure the continuity of personnel supply in drafting and designing tooling and work processing.

5. To establish a proto-type and developing centre to support the design work by providing it with the practical atmosphere essentially needed for its proofing.

6. To work out the necessary plan that ensures continual emittance of designers to the various productive centres which would become the natural cause for coagulation design activities all over the country notwithstanding the state of industry whether being privately or state owned.

7. To promote the establishment of Industrial Estates which are to be supported by well documented products suitable for production within them whether these products are spares, national art or items needed for feeding bigger industries.

ANNEX

A General Note About

The Activities and Administrative Structure of G.A.I.D.

The General Administration for the Affairs of the Industrial Designs G.A.I.D. which in the past was shortly termed the Industrial Design Administration I.D.A. and which is a part of the General Organization for Industrialization G.O.I. is composed at the present time of two main "Sectors".

Each sector has a number of divisions termed administrations which are grouped in accordance with the nature of their work and duties. One sector is known as the "design sector" while the other is known as the "executive sector".

In the meantime the G.A.I.D. as a whole is virtually divided into separate divisions, each performing a certain speciality which shall be briefly detailed in the following.

The attached administration chart illustrates the whole set-up of the department.

G.A.I.D. is at the present administrated by a Director General and it is hoped that shortly he would be assisted by two assistants each administering one of the above sectors.

The "design sector" is composed of four administrations, one is specialized in the design of factory and general equipments which are in fact items, machines or parts of machines that are used in the production of our every day commodities and needs.

The term equipment in our understanding could mean material handling, agricultural and mining, storage and even those special machines and machine parts which are of enough simple nature that would make them suitable for production by our local facilities.

The second division of that sector is specialized in the design and development of engineering products which are being produced and need development or which are not being produced but could be introduced as additional items to existing factories. The shape and design of which would naturally be based on a similar established existing product.

The third administration in the design sector is entrusted with design of tools required for the production of designed items prepared by the first two divisions.

Accordingly, it shall be responsible for drawing up the sequel and procedure of processing necessary for the production of the various items.

The fourth and last administration in that sector is termed the production planning division. It has a wide field of responsibilities as it is in fact responsible for planning the work for the three other administrations and its duties could be summarized in the following:

a. During the course of contract negotiation with the successful tenderer for any of the projects of the plan, the personnel of this division would mutually agree with the supplier on these items that could be screened out of his bulk of supply and reserved for local production.

b. They would then study in detail the specifications of the articles or items of equipment thus screened and either:

1. Arrange for the preparation of their designs and drawings with the other divisions.

2. Simply arrange to buy these designs and drawings from the tenderer and pass them over to other divisions to consider the necessity of supplying additional details or introducing any alternations or adding further remarks which would aid local producers to execute them successfully and utilizing as much as possible the indigenous raw materials and local facilities.

In other words to "translate them into the industrial language and terminology understood by the local job shops".

Naturally all above work is to be carried out with the approval of the supplier and without impairing the integrity or function of the article itself.

c. To finally prepare the technical specification needed for the local tendering and purchase of the equipment.

d. To help and advise local producers and factories, if so asked, in methods of improving their production procedures.

e. To study site preparation for extensions of old factories.

f. To act as liaison in the preparation of processes for new factories if it is felt that there is enough adequate technology exists in the country for such a process.

The second main sector of G.A.I.D. is responsible for the execution side of the problem.

It has to see that items designed by the first sector are produced to the standard of quality requested and in accordance to the agreed schedules.

It has also the responsibility of proving the designs where it needs proving and to try out the new ideas embodied in them before they are given out to Industry.

This sector of G.A.I.D. is composed of three main administrations.

The first is the inspection, progress and testing administration. It is responsible for carrying out the known duties in that respect.

The second administration is responsible for the working of the proto-type workshop whose duties shall be given separately later.

This section with its natural disposition and contacts with the market and local job-shops carry out a feed-back operation of market reflections, new technical developments in local facilities and thus provides the industrial information essential for the designers and other members of G.A.I.D. and Industry in General.

This division also administers the practical training programmes needed for the personnel of G.A.I.D. which shall naturally be centred on the proto-type shop.

The third and last division of this Sector is the economical survey and costing administration which controls market and economical studies, expenditure and cost accounting. It is also responsible for the general administrative matters.

One last remaining matter shown on the administration chart is the "project engineers" section which provides a very satisfactory co-ordinating service for the various projects handled by G.A.I.D.

## The Prime Duties of the Proto-type Workshop in Brief

The shop envisaged is to have the following characteristics:

A- To be of general purpose type of workshop.

B- It is not intended for regular production of items.

C- It is not supposed to be independently capable of producing all the parts of an item or a product unless it is very simple; but it is supposed to order parts that are beyond its modest capabilities from other specialized concerns.

D- It is expected to perform the following:

1. Modelling work for new products in clay, wood and metal.
2. Proto production work for a whole or part of an equipment containing a new idea, an alteration or a development which require proving.

The building up of a complex item is not considered possible here unless it could be affected by the collaboration and practical assistance of the interested manufacturer.

Thus this shop must contain in a general and moderate way the following facilities:

Machining and shaping.

Welding.

Assembling.

Testing and inspection.

Tooling for proto production.

With the above mentioned facilities such a shop could also produce geometrically reduced but functionally correct equipments for small pilot plant work to prove a newly designed idea or a process.

The shop is planned to house 65 personnel of different calibres but with especially high experienced technicians to satisfy the needs of the very special purpose they are expected to perform.

Such a shop, in our opinion, is an essential practical tool in the hands of new designers in a developing country where producing concerns lack the time, the facilities and the concentrated efforts to develop their own techniques in the early stages of their quickly built up industrial existence.

It shall open the way wide to young engineers, designers and draftsmen to practically see their ideas performed, it could also teach industrialists some of the new techniques of production which they would neither have the time nor the facility to perform or see otherwise.

It shall without doubt create a considerable effect on the national income and save an immense portion of the foreign capital used by the industry beside developing that side of practical thinking in the minds of the designers and draftsmen of the country.

## Tentative Five Year Programme of Work in the Proto-type Workshop

### I- Equipment

In the field of equipments the following is expected to be attempted with the aim of executing three to five proto-types yearly.

1. One spinning machine
2. One weaving machine
3. One or two types of hand operated winches to check up the series which are to be designed as a semi-standard product for local production.
4. At least one wall-type crane for small lifts.
5. Various types of pulley blocks.
6. Standard products for power transmission as bearings, clutches, couplings, little gear units etc..
7. Reduced working models for overhead cranes with an aim of semi-standardizing them.
8. Reduced working model for a tower crane.
9. One set of hydraulic handling equipment.
10. Vibrating screens and similar mining equipment.
11. Agricultural implements as the specially designed plough for our soil disc. harrow and other similar items.
12. A centrifuge.
13. A dough preparation machines for bakeries.
14. Helical conveyor
15. Large and small mixers.
16. A portable conveyor.

### II- Pilot Plant Work

Also in the line of activities in trying out equipment for pilot plant work it is envisaged that the shop would carry out one to two such plants yearly. Enlisted work for study is:

1. Aromatic oil extraction pilot plant.
2. General purpose oil extraction pilot plant.
3. Pilot plant for grading of local fruits.
4. Pilot plant for grading of vegetables.
5. Pilot plant for sugar extraction.
6. Pilot plant for pulp processing from the remains of various agricultural products.
7. Other unforeseen requests.

III- Products

In the modelling and proto-type production line of products it is ambitiously estimated that the shop shall be capable of modelling and developing ten to fifteen articles yearly. A tentative programme for earmarked products are here-in-under detailed:

1. Battery driven trucks for goods transportation inside factories.
2. Battery driven trucks for other transport purposes.
3. Hand driven trucks.
4. Hand operated lawn mowers.
5. Engine or motorized lawn mowers.
6. Machine operated brushes for roadpavement cleaning.
7. Hand operated vacuum cleaners for domestic use.
8. Motorized vacuum cleaners for home and industrial uses.
9. Development of home electric irons.
10. Development of industrial ironing means.
11. Projectors and educational aids of similar nature.
12. Light fittings for factories general.
13. Light fittings for textile humidified factories.
14. Safety equipment.
15. Simple mechanical toys using the remains of industry.
16. Domestic mixers, dryers and similar products.

The scope of these products are so large and we have endeavoured to list the items that we would handle at a start. The yearly number at the first stages would range from five to ten products and as mentioned earlier we are ambitiously looking forward for fifteen towards the later stages when the technical staff reaches maturity.

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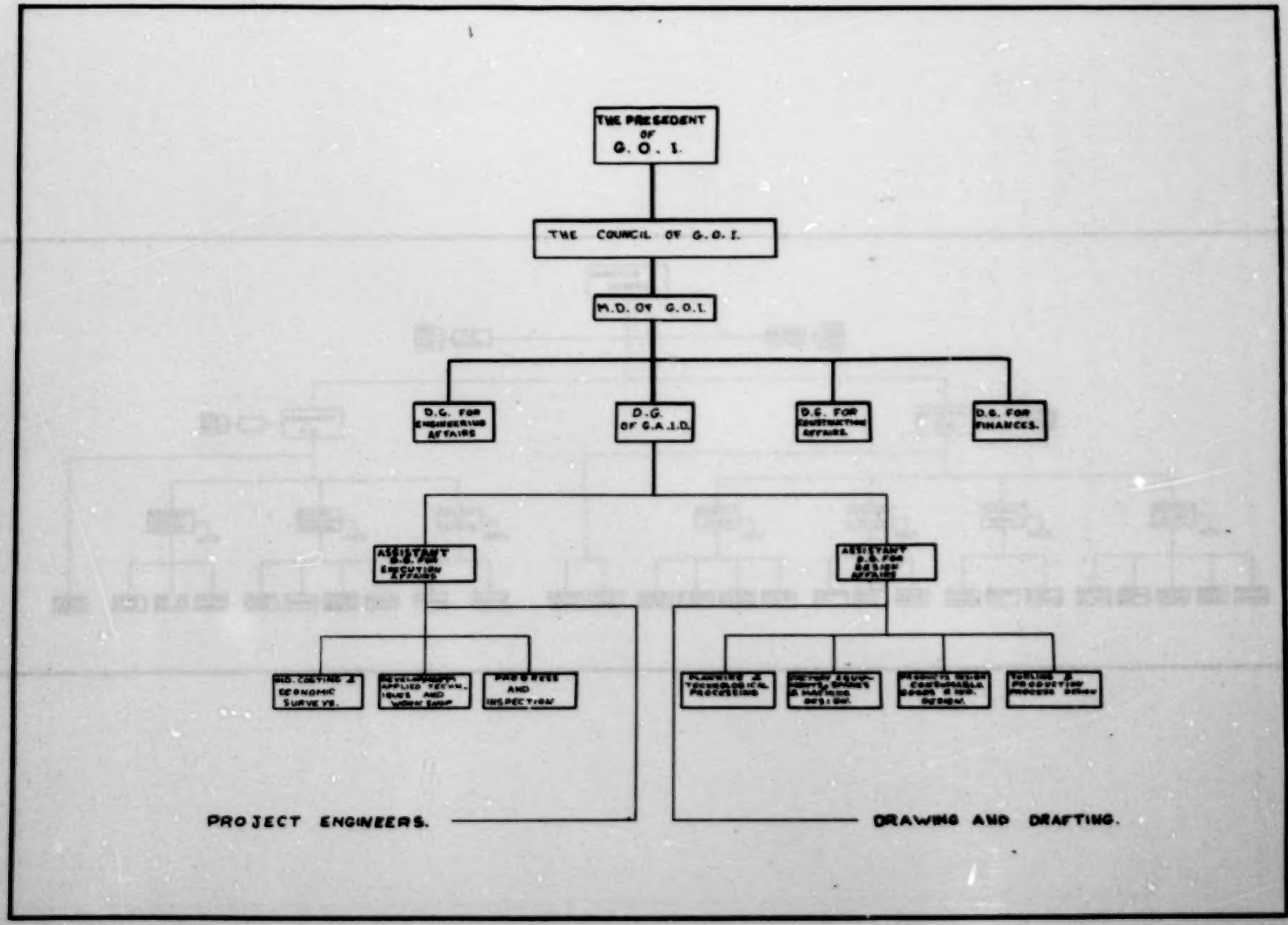
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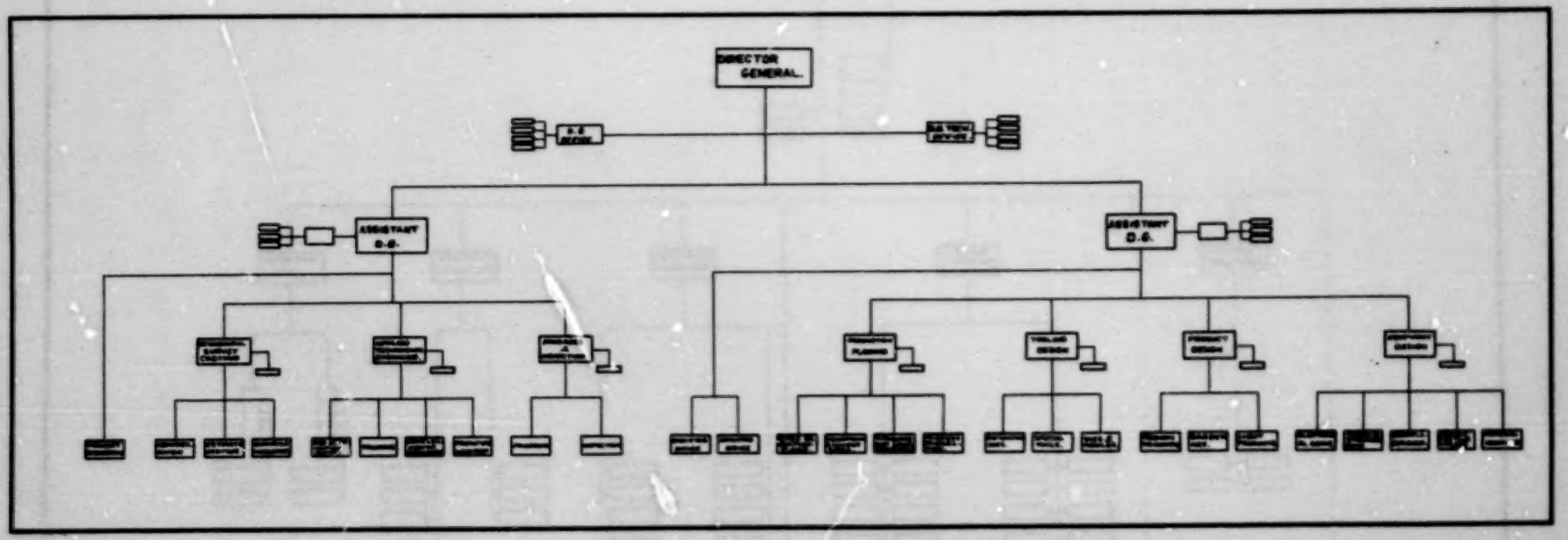
PROJECT ENGINEERS.
DRAWING AND DRAFTING.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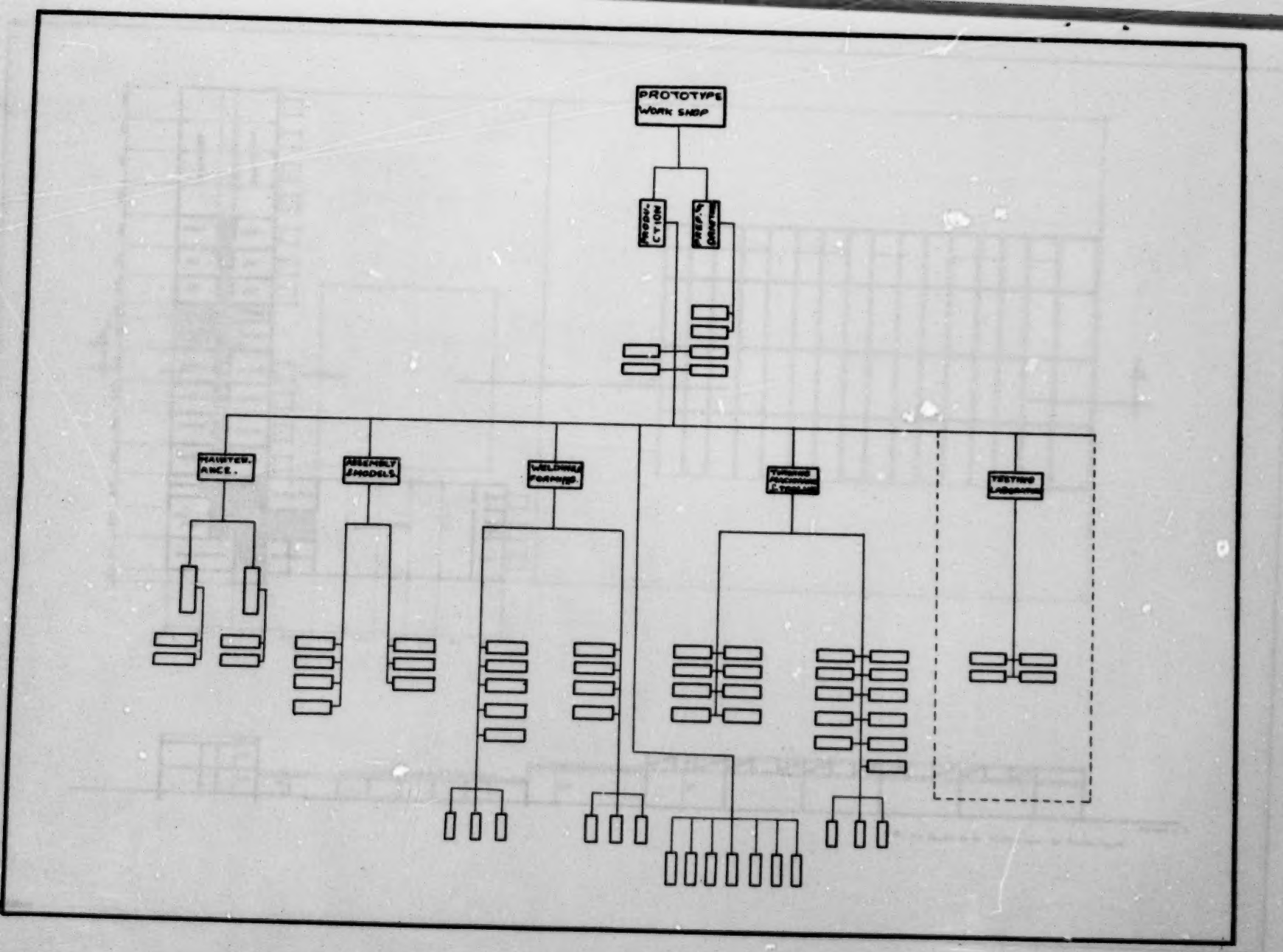
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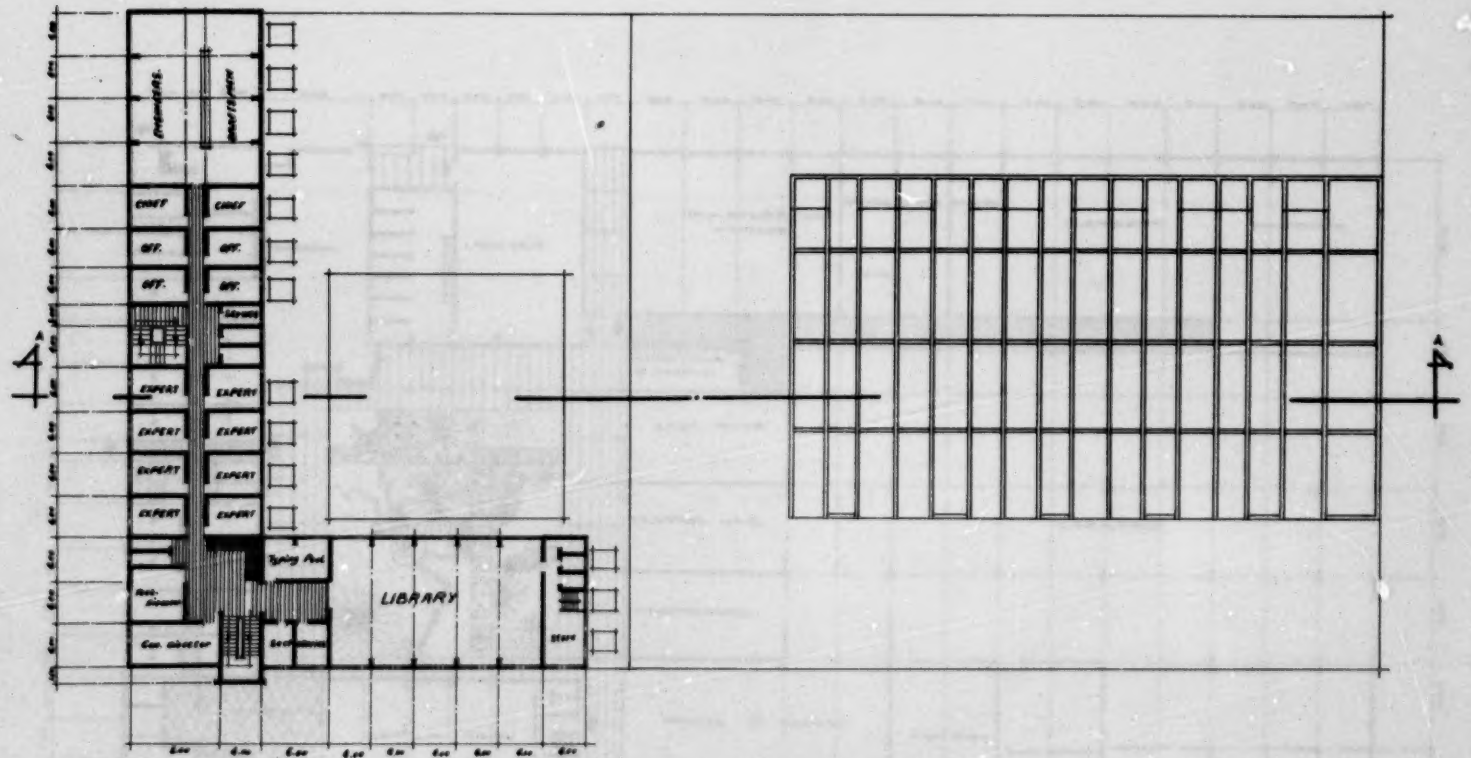
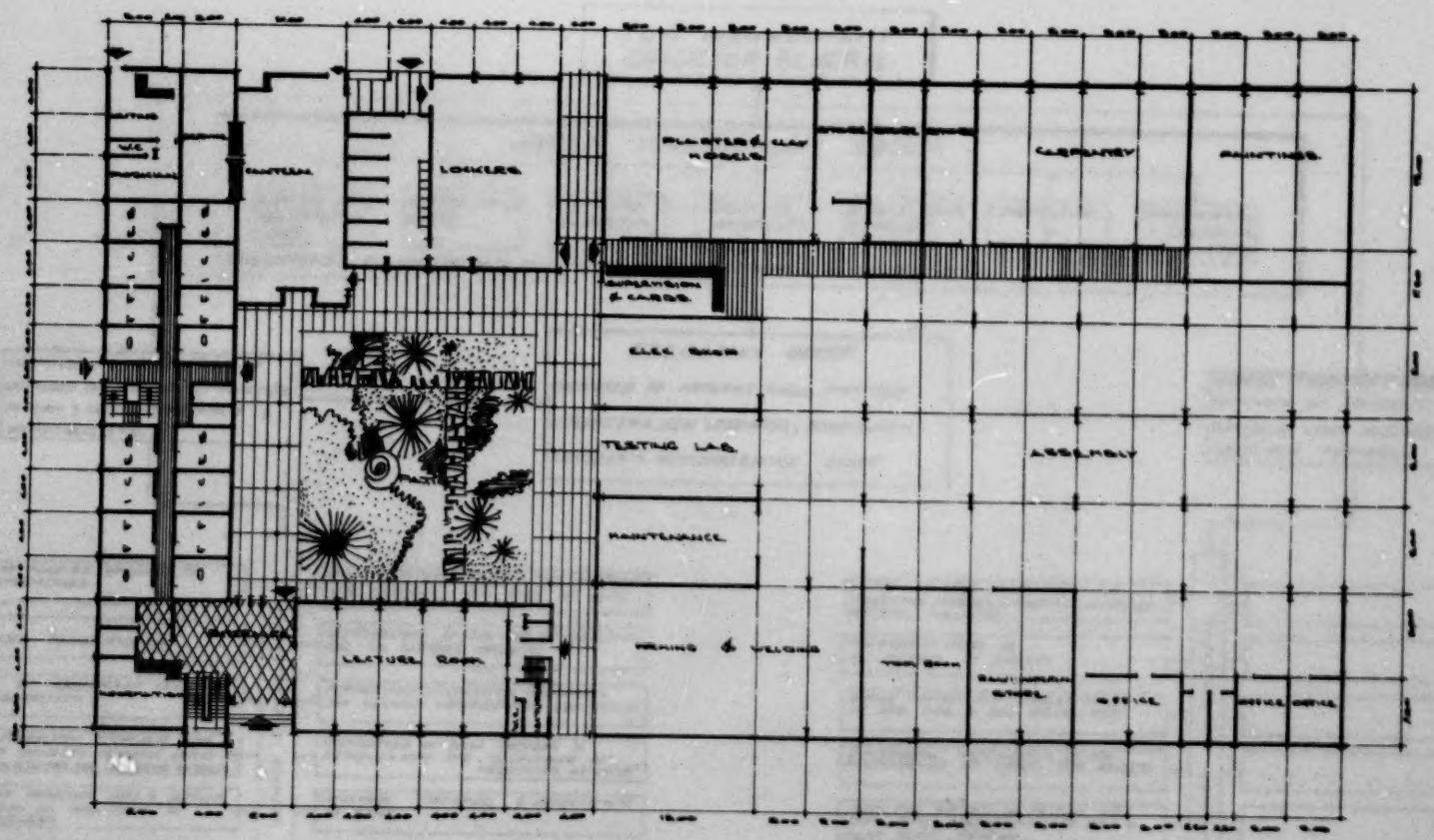
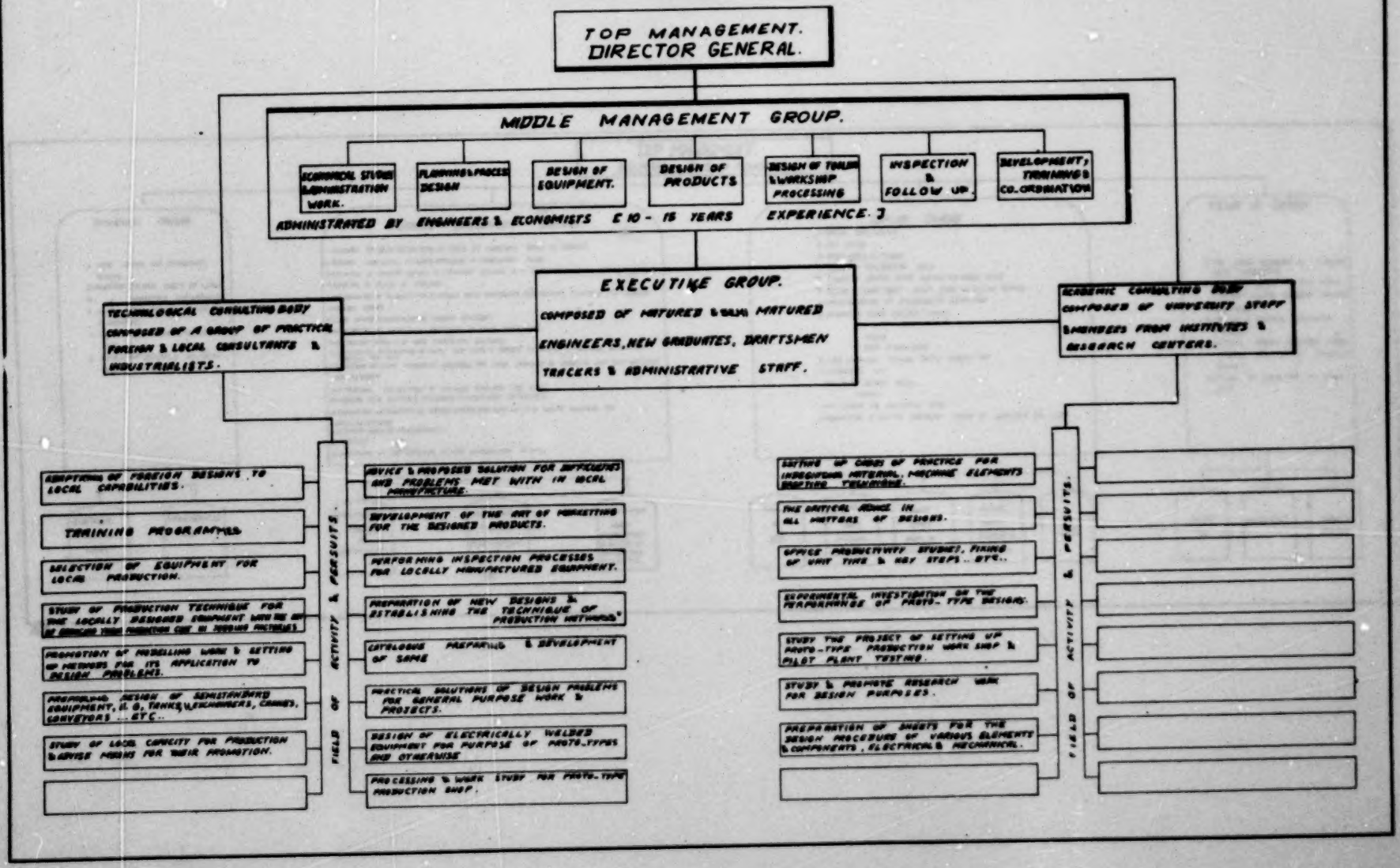
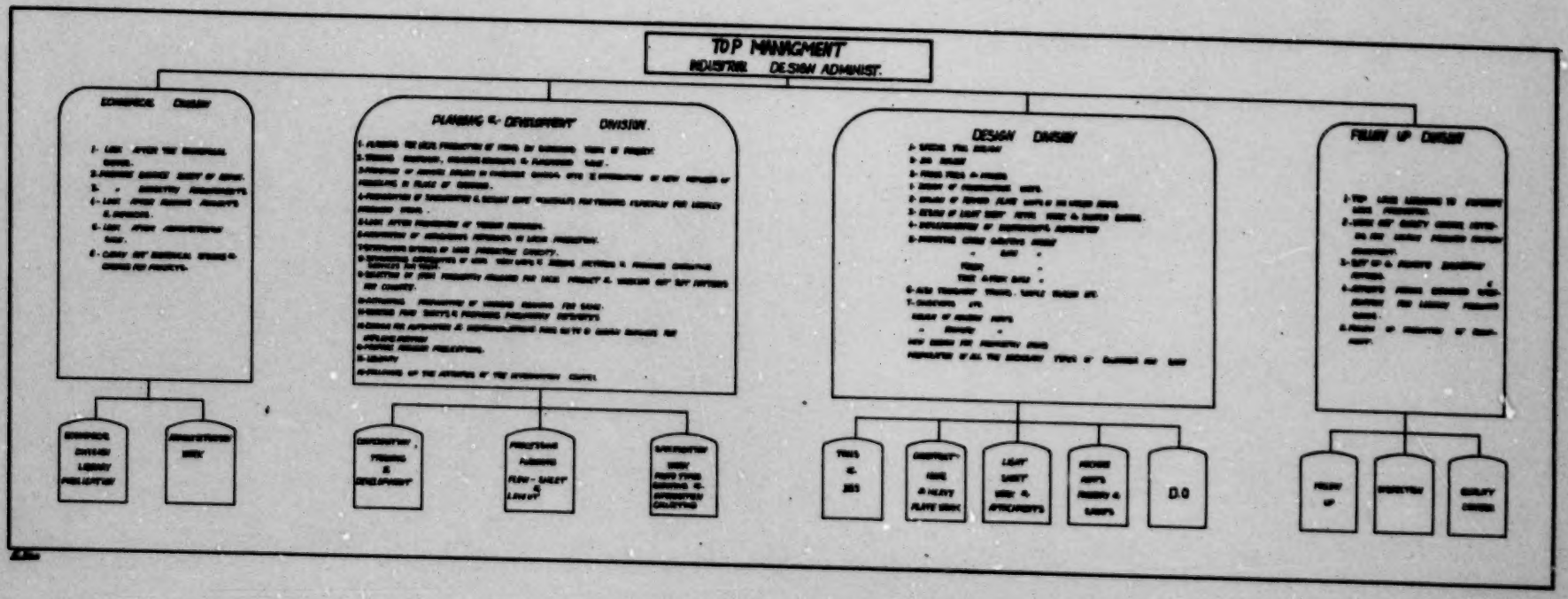



N.B. Height to be determined by technologist.


LOUVERS
TESTING LAB.
MAINTENANCE
LECTURE ROOM
ASSEMBLY

# COMBINED DESCRIPTIVE CHART
## FOR
## JOB & PERSONELL OF G.A.I.D.


TOP MANAGEMENT.
DIRECTOR GENERAL.
MIDDLE MANAGEMENT GROUP.
ECONOMICAL STUDIES & ADMINISTRATION WORK.
PLANNING & PROCESS DESIGN
DESIGN OF EQUIPMENT.
DESIGN OF PRODUCTS.
DESIGN OF TOOLS & WORKSHOP PROCESSING
INSPECTION & FOLLOW UP.
DEVELOPMENT, TRAININGS & CO-ORDINATION
ADMINISTRATED BY ENGINEERS & ECONOMISTS [ 10 - 15 YEARS EXPERIENCE. ]
EXECUTIVE GROUP.
COMPOSED OF MATURED & SEMI MATURED ENGINEERS, NEW GRADUATES, DRAFTSMEN TRACERS & ADMINISTRATIVE STAFF.
TECHNOLOGICAL CONSULTING BODY COMPOSED OF A GROUP OF PRACTICAL FOREIGN & LOCAL CONSULTANTS & INDUSTRIALISTS.
SCIENTIFIC CONSULTING BODY COMPOSED OF UNIVERSITY STAFF & MEMBERS FROM INSTITUTES & RESEARCH CENTERS.
FIELD OF ACTIVITY & PURSUITS.
ADAPTATION OF FOREIGN DESIGNS TO LOCAL CAPABILITIES.
TRAINING PROGRAMMES.
SELECTION OF EQUIPMENT FOR LOCAL PRODUCTION.
STUDY OF PRODUCTION TECHNIQUE FOR THE LOCALLY DESIGNED EQUIPMENT WITH THE AIM OF REDUCING THEIR PRODUCTION COST BY REDUCING FACTORIES
PROMOTION OF MODELLING WORK & SETTING UP METHODS FOR ITS APPLICATION TO DESIGN PROBLEMS.
PREPARATION DESIGN OF SEMI-STANDARD EQUIPMENT, H. E., TANKS, EXCHANGERS, CRANES, CONVEYORS ... ETC ..
STUDY OF LOCAL CAPACITY FOR PRODUCTION & ADVISE MEANS FOR THEIR PROMOTION.
ADVICE & PROPOSED SOLUTION FOR DIFFICULTIES AND PROBLEMS MET WITH IN LOCAL MANUFACTURE.
DEVELOPMENT OF THE ART OF MARKETING FOR THE DESIGNED PRODUCTS.
PERFORMING INSPECTION PROCESSES FOR LOCALLY MANUFACTURED EQUIPMENT.
PREPARATION OF NEW DESIGNS & ESTABLISHING THE TECHNIQUE OF PRODUCTION METHODS.
CATALOGUE PREPARING & DEVELOPMENT OF SAME
PRACTICAL SOLUTIONS OF DESIGN PROBLEMS FOR GENERAL PURPOSE WORK & PROJECTS.
DESIGN OF ELECTRICALLY WELDED EQUIPMENT FOR PURPOSE OF PROTO-TYPES AND OTHERWISE
PROCESSING & WORK STUDY FOR PROTO-TYPE PRODUCTION SHOP.
SETTING UP CODES OF PRACTICE FOR INSPECTION MATERIAL, MACHINE ELEMENTS ADOPTING TECHNIQUE.
THE CRITICAL REVIEW IN ALL MATTERS OF DESIGNS.
OFFICE PRODUCTIVITY STUDIES, FIXING OF UNIT TIME & KEY STEPS .. ETC..
EXPERIMENTAL INVESTIGATION ON THE PERFORMANCE OF PROTO-TYPE DESIGNS.
STUDY THE PROJECT OF SETTING UP PROTO-TYPE PRODUCTION WORK SHOP & PILOT PLANT TESTING.
STUDY & PROMOTE RESEARCH WORK FOR DESIGN PURPOSES.
PREPARATION OF SHEETS FOR THE DESIGN PROCEDURE OF VARIOUS ELEMENTS & COMPONENTS, ELECTRICAL & MECHANICAL.
FIELD OF ACTIVITY & PURSUITS.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# ON THE PROMOTION OF DESIGN FACILITIES IN INDUSTRIALLY DEVELOPING COUNTRIES.

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# ON THE PROMOTION OF DESIGN FACILITIES IN INDUSTRIALLY DEVELOPING COUNTRIES

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This paper is concerned with outlining ways and means of developing design facilities, the awareness of the paramount importance of design work and of its significant influence on national economy being first emphasized.

Design facilities are regarded as comprising the availability of competent staff, production equipment, testing apparatus and technical documentation. Methods of preparing designers through tuition and training are discussed, and the importance of disseminating design information and data is pointed out.

For industrially developing countries, the current accute shortage of design facilities imposes an additional objective, namely that of the most efficient use of available facilities.

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## INTRODUCTION

In an industrial country, various industries would have passed, during their natural path of development, through several stages, viz.:

(i) Copying and adaptation,
(ii) Improvement, modification and development,
(iii) Creation and invention.

Transfer from one stage to the next mainly depends on the rate and extent of accumulating knowledge and experiences in the particular industry. The natural development of industry would evidently extend over a relatively long period of time.

Developing countries who intend, however, to get industrialized within fairly close limits of time, would strive at increasing the rate of industrial development by the following means:

(a) Higher capital investment in industrial projects,
(b) Increased rate of technical education and training,
(c) Development of potential creative abilities in the industrial field.

The first two means are quite well understood, while the vital importance of the third item is not as yet fully appreciated, in spite of the fact that the design function forms the hub of all engineering activity, without which no genuine development could be achieved. It is this aspect of problems facing industrially developing countries which is dealt with in this paper.

It may not be too difficult to erect and run extensive industrial concerns, but it is not at all easy to effect real improvements and developments in materials, processes, equipment and products without advanced expert knowledge and creative ability in the field concerned. The continued and tedious search for furnishing better, though cheaper, industrial products evolves from the keen competition between industrial concerns who, in some cases, fight all the way for their very existence.

Advanced technical knowledge now forms effective means for exerting economic as well as political pressure, hence the absolute need for the rapid and intensive development of national resources of creative abilities, should a developing country endeavour to secure its industrial status and national income.

## CONTEMPORARY INTEREST IN DESIGN WORK

It is not just a coincidence that pronounced interest in and increased awareness of the importance of design has recently been displayed by the frequent holding of relevant conferences* and symposia, and the publication of specialized reports, studies and papers on design (e.g. 1 - 27)**. This contemporary interest is quite rightly justified in a rapidly developing and keenly competitive world, in which design is playing a most significant role in the battle for industrial survival and enhanced productivity. The growing awareness of the importance of good engineering design and its impact, through production and relevant sales on the national income has led industrially developed countries to pay careful attention to potential creative faculties and to ways and means of developing these faculties through university tuition and industrial training.

Sound designs, innovations and the development of more efficient production techniques and engineering materials should be the aim of serious intentions for industrialization. Possession and careful

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*e.g. First Conference on "Engineering Design Education", held at Case University, 8th. - 9th. September 1960.

Conference on "Design Methods", held at Imperial College, London, 28th. September 1962.

Conference on "The Practice of, and Education for, Engineering Design", held at the Institution of Mechanical Engineers, London 16th. - 17th. October 1963.

Conference on "Teaching of Engineering Design", Scarborough, 1964.

& Conference on "Organization for Design", to be held by the Institution of Mechanical Engineers, London, on 15th. and 16th. February 1966.

**See references at end of paper.

handling of advanced technical information have proven to be quite a decisive factor in the stability of the industrial set-up. Scientific and engineering achievements, successfully applied in the industrial field, shall remain for a long time the basic criterion for survival.

In the light of these contemporary trends of rapid technological progress, and ever increasing rate of world competition, industrially developing countries are to be strongly recommended, at all stages of development, not to overlook the importance of design work, at least in as far as it provides safeguard against technical isolation and economical pressure. The establishment of industrial concerns should by all means be accompanied by serious and intensive studies of relevant techniques, equipment and products as a pre-requisite for current and future independent creative work.

The well known "Feilden Committee Report" (2, 3, 4) spared no effort in emphasizing the paramount importance of engineering design as it affects products' performance, reliability, appearance, delivery and price. To quote but a few of Feilden's words (3) are the following:

> "Every industry is dependent upon engineering for capital plant and equipment; the quality of engineering design is, therefore, a major factor in costs and productivity.
>
> Where the importance of design is appreciated and the design team is adequately staffed and given its proper status, British products are outstanding".

Principal conclusions and recommendations of the committee (2) include:

(a) Emphasis of vital importance of design in engineering and consequently in the national economy.

(b) Urgent need for more able people to train as professional engineers, especially as designers; encouragement of more talented engineers to make their careers in design.

(c) Need for increase of the prestige of design and the status of designers.

(d) Establishment of institutes for advanced studies in particular fields of design in close association with industry; establishment of a higher degree in engineering design.

(e) Encouragement of good design practice and of the preparation of design manuals.

It should be evident from these statements to what extent a well developed industrial nation is deeply aware of the significant role played by design and its impact on national economy. It must be, herein, pointed out that these symptoms should not be looked upon as being mainly confined to developed countries, as all nations marching along the hard and long route of industrialization shall, sooner or later be faced with the inadequacy of design facilities, in case no provision to avoid such situation be taken in the industrial plan.

## NATURE AND LIMITATIONS OF DESIGN

As expressed in a recent report (4), design may be regarded as "the highest manifestation of the art and science of mechanical engineering". How true and precise is this statement.

The term 'design' may be used to denote creative planning or development work set out to meet specific requirements, making best use of materials and processes known to mankind. Good designs should aim at minimum size, mass and cost, also maximum efficiency and endurance, and best appearance.

In his approach to the problem, the designer would try to formulate as many solutions as possible, which would meet the stipulated requirements. He would then analyse these solutions in the light of his knowledge of relevant engineering subjects in an attempt to reach the most acceptable and promising solution.

A particular feature pertaining to design work is that no absolute criterion of success or perfection does exist. The designer would, in general, be faced with several criteria which most often conflict with

each other. Under such circumstances, the designer would have to seek some compromise, guided by his analysis, talent and professional experience. This type of work would, no doubt, call for men with creative abilities, who should be given proper tuition and training before they can be permitted to practice 'Design Engineering'.

Any industrial set-up should take all necessary measures as to develop its potential creative faculties and promote material aspects of design facilities, should stability, progress and increased productivity be sought.

## DESIGN FACILITIES

By design facilities is meant intellectual and material resources made available for carrying out design work.

Intellectual facilities constitute competent designers who have acquired sufficient technical knowledge and experience, in conjunction with inherent abilities, so as to be able to tackle design problems assigned to them. A good designer is expected to possess the following capabilities:

(a) Basic theoretical background in engineering,
(b) Professional experience in actual engineering concerns,
(c) Training in design work in competent development and research departments;
(d) Technical imagination and creative ability.

The fact that many industrial countries suffer from lack of designers has been discussed in recent publications (e.g. 2, 4 and 7). Great emphasis has been placed on the encouragement of graduates with high intellectual capacity to take up design engineering as a career. Preparation of designers through university tuition, advanced studies and training in industry has also received careful attention (8 - 26).

On the material side of design facilities are the availability of production equipment and testing apparatus. In industrially developed countries, it would be feasible to expect many concerns to possess their own facilities. This would be justified in an advanced stage of development in a country living mainly on its export of industrial products. Under such circumstances the rule in the battle of productivity would be 'produce or perish'. It would be superfluous, in this paper, to emphasize the significant role of design in productivity.

In industrially developing countries, however, limitations in intellectual and material resources call for planning schemes for the best utilization of available facilities. Design work may thus be conducted in close co-operation with industrial concerns, research organizations and university laboratories, until the extent of work becomes so extensive and promising as to justify having independent facilities.

Industrially developing countries are recommended not to overlook, at any stage of development, the importance of design work by planning new industries to include development departments, with reasonable production, testing and research facilities.

Last but not least of material aspects of design facilities are the preparation, documentation and dissemination of design information and data. This would be achieved through the co-operation of professional institutions, universities and industry.

As qualified manpower is, in my opinion, the keystone of design facilities, problems facing the preparation of competent designers are, hereunder, discussed in detail. The additional problem, facing industrially developing countries in particular, i.e. that of the most efficient use of professional engineers and in particular of designers, is also outlined with recommendations as to some plausible solutions.

## TEACHING OF DESIGN

This aspect of design facilities has been, in recent years, the subject of numerous discussions, reports and papers (8, 9, 11, 12, 14, 16-19, 21, 22, 24-26), relevant methods, experiments and trends being examined at great length. It is not intended in this paper to discuss the problem of the theoretical training of designers in detail, but rather to give a brief evaluation of present state of affairs.

Owing to intensive concentration on basic sciences during the last two decades, time allocated to design teaching in many universities was seriously affected. This unfortunate deviation in engineering education is responsible for the present shortage of designers as suffered by almost all countries whether industrially developed or otherwise. This phenomenon, together with the genuine understanding and recognition of the importance of design, by men of learning, academic and industrial bodies seem to be the direct cause for what we may call contemporary "Reappraisal of Engineering Design".

By virtue of their nature, engineering design problems do not, in general, have single definite solutions. The number of unknowns, in the design problem, usually exceeds the number of equations, hence the need for making plausible assumptions, and carrying out more than one trial before a reasonable solution could be reached. Moreover, the designers may, generally, be confronted with a number of possible and feasible solutions among which he will have to seek the most suitable answer in the light of his judgement and experience.

Design approaches may be broadly classified in two main categories, namely:

(a) Traditional Approach: This is based, to a substantial extent, on previous experience, empirical formulae and trade codes. Such approach had been in common use a few decades ago.

(b) Rational Approach: This is founded on the application of scientific information and technical data, through analysis

and synthesis to the development of solutions which are then evaluated before relevant decision be taken as to the most suitable solution to the problem under consideration.

This latter approach evolved from the rapid scientific and technological progress, also from contemporary scientific attitude and call for most efficient utilization of engineering materials and other resources. It represents the modern trend in design engineering.

The analysis of the methodology of design has shown that education of engineers differs from that of scientists in that design forms the hub of engineering activities; consequently the educational set-up shall have to be directed to this fundamental objective.

Standard methods of teaching design have so far been virtually methods dealing with "Case Studies" of somewhat orthodox nature, for which relevant literature is available, and the extent of originality is limited to some extension of existing knowledge. Of these standard methods two types can be identified, viz.:

(a) Design studies of complete projects, with work carried out in great detail. This method (as mainly adopted on the Continent) has been found quite effective in teaching design of rather well known components and units.

(b) Design studies of few elements with emphasis mainly placed on theoretical and analytical work. This method would hardly serve the purpose of design teaching, as analytical work would have already been tackled in respective fields.

"Case-Study" methods of teaching would, by no means, be considered adequate, owing to the fact that they really constitute, in the main, copying work with no or at best little creative contributions.

Case studies would, however, be most suitable and essential in the capacity of a first stage course in design. Preparation of designers should, however, go far beyond these studies.

Recent trends in design methods show that two further stages should be incorporated in the teaching programme; these are:

(i) Case Histories: in which the evolution and development of existing engineering design solutions are studied in detail, e.g. the evolution of gearing, transmission systems, machine tools etc., alternative designs being thoroughly examined.

These would be a necessary requisite before the final stage which follows could be undertaken.

(ii) Creative projects: in which work calling for technical imagination and inventive ability should be attempted. These studies should, by all means, be carried out in close association with industry whenever possible.

This would lead us eventually to the importance of training designers in industry in line with their basic training in academic institutions.

## TRAINING IN INDUSTRY

The conception of training designers in industry is quite a serious one. Such training, which should bridge design and production engineering aspects, must never be overlooked if preparation of competent designers is sought. Designers should not only be given access to research and development departments in leading industrial concerns, but as pointed out before, closer co-operation between academic institutions and industry should be dealt at an earlier stage by undergraduate as well as by postgraduate students, through the organization of corporate projects carried out in collaboration with and to the benefit of industry.

The need for forming large teams of design engineers has been expressed on several occasions, the idea being already put in actual practice several years ago. Trainees would preferably be allowed to join a design team, and should be given some degree of responsibility

that would be increased in liaison with abilities displayed in the course of work.

Without adequate training in industry, designers may not be expected, in general, to furnish the most suitable and practical designs, within time limits set for the job. This may, in some cases, entail serious financial loss.

## DESIGN DATA

One of the principal recommendations proposed for the promotion of design facilities is the preparation, documentation and dissemination of design data (2, 27). Measures should be taken by professional, academic and research institutions to set up joint committees for the preparation of authoritative design data sheets and manuals, necessary funds being allocated for the purpose. Publication of such data would naturally be of invaluable assistance to designers.

Moreover, should some system of documentation of past designs be arranged in such a manner as to facilitate identification and location of such designs, much time and effort could be saved on the part of designers who would then concentrate on new designs only. If technical information appearing in engineering and science journals and periodicals could also be made available and be properly classified, effective use of technical literature would be made possible for teams of designers.

All these measures would, no doubt, greatly contribute to the enhancement of design facilities in an industrial community.

## EFFICIENT USE OF DESIGNERS

A special problem facing industrially developing countries is the relatively limited number of professional men available. Such deficiency, which may be reduced or even eliminated over the years, through suitable education and training, should find an immediate and ready solution

through the proper use of scientific, technological and technical manpower.

As far as design facilities are concerned, men of experience in industry should take, besides their original duties, active part in schemes set up for the preparation of engineering designers, through some part-time arrangement.

Professional engineers in industrially developing countries should, by all means, be relieved from non-technical duties which could otherwise be carried out by non-engineers. Existing abilities should be developed to the fullest extent and plans for improving the quality and quantity of design engineers should come into immediate effect.

## SUMMARY AND CONCLUSION

In this work the phenomenon of contemporary reappraisal of design engineering is pointed out and relevant means of harnessing and promoting design facilities are investigated.

The nature and limitations of engineering design are discussed and methods of its teaching are examined. It is herein established that the rational approach to design problems should be followed, and that an effective scheme for the preparation of designers should be based on a three stage programme, viz. case studies and case histories culminating in creative work.

The importance of training designers in industry is emphasized, and close co-operation between industry and academic institutions is advocated. Design studies should include projects carried out in collaboration with and to the benefit of industry.

A substantial contribution to design facilities may also be effected through the preparation, documentation and dissemination of design data and relevant technical information.

Industrially developing countries are recommended to make most efficient use of their rather limited resources of professional engineers and of material facilities, with a view to overcoming current shortage therein. Ambitious industrial plans should incorporate suitable schemes for the preparation of engineering designers, who would no doubt be the key figures responsible for genuine technological progress in the highly competitive world of today.

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